

REMARKS

Claims 21-25, 27-36 and 38-45, all the claims pending in the application, stand rejected.
Claims 28-31, 42 and 43 are amended.

Support for the amendments is found in the original claims and, as to claims 31 and 43, in the original specification at page 14, lines 23 to 24.

Claim Rejections - 35 USC § 112

Claim 42. is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

The Examiner notes that claim 42 recites "... a pattern of which a design size is 0.4 pm or more and 2.0pm or less..." and asks whether this is intended to mean that the design size is between 0.4 pm and 2.0 pm?

The language has been clarified.

Claim Rejections - 35 USC § 102

Claims 21, 22, 31, 32, 36, 38-40, 42 and 43 are rejected under 35 U.S.C. 102(b) as being anticipated by Kwon et al. in Loading Effect Parameters at Dry Etcher System and Their Analysis at Mask-to-Mask Loading and Within-Mask Loading, SPIE Vol. 4562 pp. 79-87 (hereinafter, Kwon). This rejection is traversed for at least the following reasons.

Claims 21 and 39

In framing this rejection of independent claims 21 and 39, and the claims that depend therefrom, the Examiner appears to conclude that Kwon teaches etching at a power level below that which causes a jump in plasma density, notwithstanding Applicants' strong assertion that there is no discussion that a plasma density jump might or might not take place in Kwon et al.

Contrary to the Examiner's assertion that power is the only important parameter, as would be known by those skilled in this art, the occurrence of a plasma density jump is not simply present based upon the existence of a given level of plasma source power and a given level of chamber pressure, but depends greatly on the environment of generating plasma, namely, the configuration and a size of an etching apparatus.

Thus, even if a source power between 140 and 250 watts and a pressure between 9 and 16 mTorr are disclosed in Kwon et al, there is no basis for concluding that a plasma density jump

actually occurs or not. There is no information given as to the other significant parameters related to the existence or not of a plasma density jump. One skilled in the art would know that, where etching apparatuses are of different size and configuration from each other, the plasma density is largely varied, even if the plasma source power are equal in both etching apparatuses.

Indeed, no one, including one skilled in the art, could know from the disclosure in Kwon et al whether the plasma excitation power is lower or higher than plasma excitation power at which the plasma density jump occurs. It is impermissible for the Examiner to make this critical assumption. Only Applicants first discovered this critical relationship between an absence of plasma density jump and problems with attaining highly accurate etching.

According to the present invention, using the plasma excitation power lower than the plasma excitation power of generating the plasma density jump brings about the advantages in that:

- a conversion difference (as is referred to in page 2, lines 22 to 26 of the present specification) can be minimized between the resist pattern and a pattern formed on the chromium-based film;
- a variation of the conversion difference depending upon a pattern size can be suppressed; and
- generation of tapered portions on side walls of the patterned chromium-based film can be avoided and verticalness in the section can be improved.

The above-mentioned advantages would not be understood or other wise expected from the conventional arts, such as Kwon et al. Therefore, Applicants respectfully submit that claims 21 and 39 are not obvious from Kwon et al and are patentable over Kwon together with their dependent claims.

Amendments to Claims 31 and 43

In the amended claims 31 and 43, an organic product other than a resist and its derivative is present during etching and is deposited on side walls of a resist pattern. Such deposition of the organic product serves to cancel etching of the resist pattern (page 15, lines 8 to 9 of the English text). Given this amendment, the Examiner's interpretation of Kwon et al would no longer apply.

Claim Rejections - 35 USC § 103

Claims 23-25, 27, 28, 30, 44 and 45 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kwon, as applied above to claims 28 and 39, in view of Oh et al. in Proc. SPIE Vol. 4186, pp. 532-539, Dry Etching Technology of Cr and MoSi Layers Using High-Density Plasma Source (hereinafter, Oh).

The Examiner admits that Kwon does not teach biasing the substrate by applying a high frequency power. The Examiner looks to Oh for additional details regarding the apparatus that is used by Kwon, particularly at page 81 of Kwon and Kwon's reference 5.

Oh does not remedy the basic deficiencies of Kwon with regard to using a plasma excitation power lower than the plasma excitation power of generating the plasma density jump as regards to claims 21 and 39. Further, Oh does not render the amended recitation in claims 31 and 43 obvious.

Thus, the parent claims and the above rejected dependent claims would be patentable of Kwon in view of Oh.

Claim 29 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kwon in view of Oh, as applied above to claims 28, in view of US Patent 4,613,401 issued to Hoshino and further in view of US Patent 6,913,706 issued to Yan et al. (hereinafter, Yan).

The Examiner admits that the combination of Kwon and Oh does not teach adding an organic gas to the etchant. The Examiner looks to Hoshino for a teaching of adding ethanol vapor to a plasma etching gas when etching Cr. The Examiner further looks to Yan for a teaching that chromium-oxychloride is produced when Cr is plasma etched with Cl₂ and O₂ (column 2, lines 22-24).

Hoshino

Hoshino discloses adding ethyl or methyl alcohol vapor to an etchant gas containing a halide of a hydrocarbon such as CCl₄ and oxygen gas. Such addition of ethyl or methyl alcohol might be effective to increase a dry etching rate. In this event, an increase of the etching rate is based on a reaction of Equation (2) (column 4, line 34 of Hoshino). According to Equation (2), CrO₂Cl₂ is reduced into CrCl₃ that is stable and that is not deposited on a chromium layer to be etched. From this fact, it is readily understood that the ethyl alcohol is used as a reducing agent.

This shows that no consideration is made at all in Hoshino about either depositing an organic product on a side wall of a resist layer or cancellation of etching and deposition.

On the other hand, the currently amended claims 31 and 43 disclose depositing, on the side wall of the resist film, the organic product supplied during etching the thin film and thereby, canceling the etching and the deposition of the organic product. As a result, it is possible to make the resist pattern coincide with a chromium film pattern and to improve a sectional configuration.

Yan

The Examiner points out that Yan teaches production of CrO_2Cl_2 in etching of Cr by the use of oxygen and chlorine. However, even if the addition of ethyl alcohol disclosed in Hoshino would be combined with the etching conditions disclosed by Yan, one skilled in the art would not attain the advantages of the present invention mentioned above.

Claims 33-35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kwon, as applied above to claim 32, in view of US Patent 4,613,401 issued to Hoshino and further in view of Yan.

The foregoing comments would apply to overcoming this rejection as well.

Claim 41 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kwon, as applied above to claim 40, in view of Zhang (6,989,603). This rejection is traversed for at least the following reasons.

The Examiner admits that Kwon does not teach a mask comprising an optical proximity correction pattern and looks to Zhang for such teaching. However, Zhang does not remedy the deficiencies of Kwon and, thus, the dependent claim would be patentable for reasons already given.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

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